

# **NORTHWEST ENVIRONMENTAL SERVICES, INC.**



June 17, 2010

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Mr. Doug Glackin  
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P.O. Box AJ  
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Subject: Additional Assessment Report and Site Monitoring Reports:

Former Service Station  
Climbing Hill, Iowa  
Reg. No. 9217516, LUST No. 8LTU14

Woodbury Central Community School District Shop Building  
Climbing Hill, Iowa  
Reg. No. 8811618, LUST No. 7LTV89

Dear Mr. Benjamin and Mr. Glackin:

This correspondence provides an additional assessment report and site monitoring reports (SMRs) for the referenced sites. The primary objective of the additional assessment was to obtain water level measurements from water supply wells in the vicinity of the sites and determine groundwater flow in the shallow aquifer underlying Climbing Hill. Additional assessment and monitoring activities also include additional drinking water and groundwater sampling and analysis, reviewing all readily available information on the subsurface, combining this information into a comprehensive assessment report, and preparing separate SMRs for each site. As discussed in this report, the site plan map has continued to be revised and improved and the current and most accurate map is provided as Figure 1.

## Initial Water Quality Testing of the Benjamin Well

During the corrective action teleconferences conducted on March 21, 2010, it was decided to evaluate the Benjamin well as an alternative water source. This evaluation was to include the installation of monitoring and observation wells and yield testing the Benjamin well. Initial water quality testing of

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the Benjamin well indicated a nitrate concretion of 43 mg/L, over four times the maximum contaminant level (MCL). Laboratory reports are provided as Attachment A. As a result of this initial testing, further evaluation of the Benjamin well as an alternative water source was suspended. A budget for this initial testing was approved by Mr. James Gastineau with Aon Risk Management prior to submittal of the final work plan and budget.

#### Work Plan for Additional Assessment

The scope of service for the additional assessment activities was based on the corrective action conference held on February 23 and March 17, 2010. A work plan for the additional assessment was developed and is summarized below:

1. Resample the Benjamin well for nitrates to confirm elevated nitrate level reported by Siouxland District Health. Nitrate analysis will be performed by TestAmerica in Cedar Falls using Standard Method 4500 NO3E analysis.
2. Collect water quality samples from the Bank well and analyze the samples for bacteria, nitrate, iron, manganese, sulfate, and hardness. Bacteria analysis will be performed by ACS Laboratory in Sergeant Bluff and nitrate and other analyses will be performed by TestAmerica in Cedar Falls.
3. Collect drinking water analytical samples from the Hancock well and the School well and analyze the samples by the OA-1 and OA-2 methods.
4. Repair and redevelop monitoring wells MW-6 and MW-16, collect groundwater analytical samples from these two wells, and analyze the samples by the OA-1 and OA-2 methods.
5. Collect groundwater analytical samples from monitoring wells MW-112, MW-119R and a drinking water sample from the Bank well and analyze the samples by the OA-1 and OA-2 methods.
6. Contact well owners for permission to open eight drinking and nondrinking water supply wells to obtain water levels. The eight wells are the Benjamin well, Church well, Bank well, Lloyd well, Garvey well, Hancock well, School well, and one of the farm wells.
7. Clean and sterilize the water level meter prior to performing the field work. Open the eight wells listed above to obtain water levels and sterilize the water level meter between measurements.
8. Perform an elevation survey of the eight drinking water wells to determine water elevations and survey selected monitoring wells to verify existing elevation information.
9. Travel to the DNR records section in Des Moines and review files to obtain information on the lithology and stratigraphy in the Climbing Hill area.
10. Review drilling records kept by Nick Kohlhof and Marty Soole, well drillers who installed most of the private wells in Climbing Hill, to obtain geological and well construction information.

11. Perform a comprehensive review of available information including driller's records, IDNR records, and information from this additional assessment and incorporate the analytical data in the Tier 2/SMR software in a format determined by the IDNR.
12. Prepare a single comprehensive report for both sites that will include information from this additional assessment, and private and public records, and provide hydrogeological conclusions on the risk to drinking water in Climbing Hill. The comprehensive report will include separate Tier 2/SMR sections for each site.

### Monitoring Well Repair

In November 2009 during locating and flagging the monitoring well, MW-6 and MW-16 were observed to be in need of casing repair and new well covers. The casing for MW-6 was damaged 2 to 3 feet below grade and required excavation and casing repair before a sample could be collected. The well cover and cap were missing at MW-16 and the top of the casing was plugged with soil. The casing for MW-16 was cleared of soil and capped. Due to ground frost, the well repair could not be performed during the December monitoring event. A sample was collected in December from MW-16 but MW-6 could not be sampled because of the damaged casing.

During the December 2009 sampling event, we were unaware that MW-16 was completed and screened at a depth below the screened interval of MW-6. The well construction diagram for MW-16 indicated that the depth of the screened interval for MW-16 was 64 to 68 feet. In December an obstruction was present just below the water in MW-16. After purging the well dry and allowing the well to recover, the sample was collected above this obstruction. After the well was repaired in April, the obstruction was no longer present and the well was redeveloped by removing all loose sediment from the well bottom. After redevelopment of MW-16, a hard well bottom was measured at 50 feet.

### Water Supply Well Receptor Descriptions and Designations

The ownership descriptions of water supply wells that now include both drinking and non-drinking water wells have changed over time. Furthermore, the receptor designations or short labels used in the Tier 2 and SMR software are not the same for the two sites. Table 1 compares the well receptor descriptions and designations that have been previously used for the two sites and the descriptions and designations that reflect current ownership and are currently being used for the SMRs. If possible, the receptor designations were maintained. The Lloyd and Garvey wells were changed to NDDW-1 and NDDW-2, to indicate the change in use to nondrinking water wells. The Schlies and Hancock wells were changed to DWW-10A and DWW-10B because of label duplication.

### Site Monitoring Reports (SMRs)

The groundwater analytical results are summarized in the SMR for the School District site provided as Attachment B and the SMR for the Benjamin site provided as Attachment C. The SMR Groundwater Analytical Data Table for the School District site includes only results at monitoring wells that were used in the Tier 2 risk evaluation for that site. The Tier 2 risk evaluation and subsequent SMRs for the Benjamin site included several of the School District monitoring wells. As discussed below, the SMR groundwater analytical data set for the Benjamin site was further expanded. In order to simplify the

Tier 2 model, plugged wells were deleted from the model and no longer appear in the receptor summary tables.

In order to present all of the groundwater analytical data for the Climbing Hill sites in a single table, all groundwater analytical results not already included in the Benjamin Tier 2 model or SMR module were imported into the SMR Groundwater Analytical Data Table for the Benjamin site. This includes the groundwater analytical data used in the Tier 2 risk evaluation at the School District site and all past drinking water analytical results. As a result, the groundwater contamination plume maps provided in the Benjamin SMR are comprehensive with respect to time and location in Climbing Hill. Soil analytical data remains unchanged in both SMRs.

As part of preparing the report for the December 2009 monitoring event, the site plan map was recreated using maps in our files, copies of maps provided by the IDNR, aerial photography, and actual onsite measurements. Corrections to well locations were made as necessary and include corrections to the x,y-coordinates in the Tier 2 software. The corrections to the x,y-coordinates are illustrated on the site plan map by showing the original locations in grey and the corrected locations in red. This report includes additional corrections to building dimensions and locations and the x,y-coordinates of wells including a significant correction to the location of MW-108 based on actual onsite measurements.

Extensive problems were encountered with the Tier 2 model for the Benjamin site during preparation of the SMR. These problems required significantly more time to correct than was allowed in our budget. We revised the Tier 2 model to include a reasonable Tier 2 monitoring plan because the well selection process performed by others did not appear complete. During revision of the Tier 2 model, we recognized many other problems that required correction. The most time consuming problems to correct were associated with elevation and coordinate errors. Although we are certain that many additional error are present, the version of the Tier 2 model/software being submitted for the Benjamin site with this report is greatly improved.

### Groundwater Sampling Results

Contamination detected in the December 2009 sample collected from MW-16 was limited to 313 ppb of TEH-waste oil. TEH-waste oil concentration increased to 409 ppb in the April 2010 sample collected from MW-16 and trace levels of benzene and TEH-diesel were also detected. Contaminants were not detected in April 2010 sample collected from MW-6. The April sample from MW-16 should be considered more representative and the analytical differences between MW-6 and MW-16 appears related to the depth of the screened intervals. The groundwater analytical results and the stratigraphy described in the soil boring log for MW-16 are further discussed later in this report.

Groundwater sampling at MW-112 and MW-119R was also included in the work plan. These two wells are located in or near the downgradient transition area for the Benjamin site but were not located in December 2009 due to ice and snow cover. MW-112 could also not be located in April 2010 and is presumed to have been removed. Although MW-119R was covered with asphalt, the well was exposed and sampled. The well cover at MW-119R is damaged and needs to be replaced. The concentrations at MW-119R increased since the last sample in 2006, especially the TEH-diesel concentration which increased from 2,790 ppb to 26,500 ppb.

## Water Quality Sampling Results of Drinking Water Wells

Water quality samples were collected from the Benjamin well, Bank well, Hancock well, and School well. The Benjamin and Bank wells were sampled for nitrate, iron, manganese, sulfate, hardness and total coliform bacteria. Although the Bank well had been sampled for OA-1 and OA-2 analysis in December 2009, OA-1 and OA-2 analysis was repeated due to its high-risk classification. The Hancock and School wells were sampled for OA-1 and OA-2 analysis and were not sampled for the additional water quality parameters. The laboratory reports are provided in Attachment A and the analytical results are summarized Tables 2 and 3.

On March 23, 2010 water quality samples were collected from the Benjamin Well. The samples were analyzed by the Siouxland District Health Department Laboratory. As previously discussed, analysis of this sample indicated a nitrate concentration of 43 mg/L, over four times the maximum contaminant level (MCL) of 10 mg/L for nitrate. Although the analytical method is not indicated in the laboratory report, it is our understanding that samples from private wells are normally analyzed by use of an instrument probe. Although the water is hard, the iron, manganese, and sulfate concentrations were relatively low and coliform bacteria was not detected.

On April 29, 2010 a second sample for nitrate analysis was collected from the Benjamin well. This sample was collected from untreated water at the same outside hydrant location as the first sample. Nitrate analysis of this second sample was performed by TestAmerica in Cedar Falls using Standard Method 4500 NO<sub>3</sub>E analysis. It is our understanding that this method is acceptable for public water supply wells. The laboratory results provided in Attachment A indicate a nitrate concentration of 31.6 mg/L, which also exceeds the 10 mg/L MCL of for nitrate. Based on the depth of the well and the overlying clay soils, we consider this concentration high.

On April 22, 2010, water quality samples for OA-1 and OA-2 analysis were collected from the Bank well, Hancock well, and School well. Contaminants were not detected in the Bank or Hancock wells but as summarized in Table 3, trace levels of contaminants characteristic of gasoline were detected in the School well. This sample was untreated and collected from the outside spigot at the front of the building. On May 5, 2010, a second sample was collected from the same spigot and a third sample was collected from the sink in the men's restroom. Although it is our understanding the water supplying the restroom passes through a water softener, we were informed that this was the most likely point of exposure. Contaminants were not detected in this second round of samples.

On April 29, 2010, water quality samples for nitrate, iron, manganese, sulfate, hardness and total coliform bacteria were collected from the Bank well. A review of Table 2 indicates that nitrate was not detected and the water is considered hard with low to moderate levels of other water quality parameters. Due to the short holding time, the bacteria analysis was performed the ACS Laboratory in Sergeant Bluff and analysis indicated the presence of total coliform. This sample was collected from an outside hydrant and upon further inspection of the sampling location; a cistern or concrete covered pipe pit was observed below the hydrant.

Because the lower hydrant drain valve located in the cistern or pipe pit could easily be a source of bacteria contamination at the hydrant, a second sample was collected on May 1, 2010 from an indoor

location. The second sample was collected from the sink facet inside the butcher shop. The facet was not equipped with an aeration or filter device and prior to sample collection, water was allowed to flow from the facet for 30 minutes with the valve wide open. As indicated in Table 2, this second sample was also positive for bacteria. Pat Benjamin and the beauty shop operator were informed of the presence of bacteria, but we were not able to contact the resident of the apartment directly.

### Water Level and Elevation Survey

Water levels in existing drinking water and nondrinking water supply wells were obtained to determine groundwater flow direction in the alluvial aquifer overlying the Dakota Formation. The work plan included eight water supply wells, the Benjamin well, Schlies well, Church well, Bank well, Lloyd well, Garvey well, Hancock well, School well, and one of the farm wells. The well owners were initially contacted by telephone to briefly describe our proposed access to their wells and to confirm their mailing address. A letter that was pre-approved by the IDNR asking for permission to access the wells was mailed to each owner and permission was received to access all of the wells except the Schlies and farm wells.

On May 1, 2010, the water level survey was performed. The tape and probe of a water level meter was thoroughly cleaned and sterilized with a solution of 10 percent household bleach prior to performing the field work. This bleach concentration was based on standard laboratory procedures for instrument and probe sterilization. The water level meter was sterilized between wells and transported on site in a sterilized plastic bag. Field procedures were performed by two technicians, the first technician opened the well head and the second technician handled the water meter maintaining sterile conditions.

Although permission was granted to access both the Church well and Hancock well, water levels could not be obtained from these two wells. Opening the Church well proved to be extremely difficult. Many of the bolts securing the cover of the well were damaged and considerable effort was required to open the well. After initial attempts to lower the probe failed at the pitless adaptor, we requested Mr. Nick Kohlhof's assistance. Mr. Kohlhof indicated that the pitless adaptor was of an unusual design that occupied the entire radius of the well. Mr. Kohlhof showed an example of this style of adaptor that our probe could pass via slots on either side of the adaptor.

After several more attempts to lower the probe pass the adaptor failed and we again consulted with Mr. Kohlhof. It was Mr. Kohlhof's conclusion that an earlier model of the adaptor was installed in the Church well that was of a slightly different design with narrower slots. Mr. Kohlhof also indicated that this same type of adaptor was likely installed in the Hancock well and an alternative well upgradient of the Church well. Because of the information provided by Mr. Kohlhof, no attempt was made to open the Hancock well. As discussed in the next section of this report, the limited number of wells greatly effects of usefulness of the data obtained.

On May 8, 2010, an elevation survey of the water supply wells was performed. The top-of-casing (TOC) of MW-5 was used as a reference. Several monitoring wells along Deer Run Trail were used as survey turning points to move the instrument. The use of these monitoring wells allowed for a comparison of elevations between the two sites. In addition, to the water supply wells, the repaired wells and lateral wells that did not have elevation data entered in the Tier 2 software were surveyed.

The lateral wells included MW-108 and MW-109. The survey results of monitoring wells associated with the Benjamin site indicated elevations lower than reported in the Tier 2 software. For example, this survey indicated a TOC elevation 0.43 feet lower at MW-118 and 0.92 feet lower at MW-102.

The TOC elevations associated with monitoring wells near the Benjamin site were generally not changed because a comprehensive survey was not performed. However, a six-foot error in the ground surface elevation at MW-102 was corrected. The ground surface and TOC elevations associated with a few of the monitoring wells near the School District site were changed in the Tier 2 software files for both sites. For example, the TOC elevation for MW-11 was reduced by 0.42 feet and the TOC elevation for MW-26 was reduced by 2.38 feet. The December 2009 water elevations for MW-108 and MW-109 based on this survey were added to the Tier 2 software. These changes do not greatly affect the December 2009 groundwater flow map if the elevations differences at the Benjamin are considered.

#### Water Level and Elevation Survey Results for Water Supply Wells

The water level and elevation survey results for the water supply wells are provided in Table 4. Because the owners of the Schlies and farm wells did not allow access and because the well design of the Church and Hancock wells prevented access, only five water supply wells were surveyed. The water elevations at these five wells are shown on a topographic map provided as Figure 2. The water elevations in the water supply wells appear to generally correspond to the land surface elevation. For example, the land elevations at the Benjamin and School wells are the highest with the corresponding two highest water elevations. The School well is located on a slight hilltop. A comparison of the elevations between the Garvey and Lloyd wells indicate that this correlation is only approximate.

The lack of data from the Church, Hancock, and farm wells greatly limits the data set. If water elevations were available for these three wells, we anticipate that the water elevation in the Church well would be similar to the Benjamin well and the water elevations would be lowest in the Hancock and either of the farm wells. The relative water levels at the Garvey and Lloyd wells do not fit this pattern. This pattern generally follows the direction of groundwater flow at the water table where monitoring wells are present. Because monitoring wells are not located near the School well, shallow groundwater flow direction near the School well is uncertain. It should be noted that the Bank well is 40 to 50 feet deeper than the other wells with known depths and this well is completed in Dakota sandstone.

It was suggested during the last corrective action conference that groundwater flow in the alluvial sand above the Dakota Formation was likely towards the West Fork of the Little Sioux River located approximately a half mile west of the sites. It should be noted that groundwater flow in both the loess and the alluvial aquifers flow appears to be primarily in a westerly direction, although this observation is highly approximate for the alluvial aquifer. Because of the limited size of the data set, caution should be used in drawing any conclusions from this survey. The results of this survey indicates that groundwater flow in the alluvial sand and the overlying loess are somewhat similar and suggests that the alluvial sands are hydraulically connected to the more shallow groundwater near the water table.

## Review of DNR Files and Drillers' Records

On April 28, 2010 the DNR files were reviewed to obtain records on the sites especially with respect to the geology of the Climbing Hill area. Because of obvious gaps in the data, we subsequently inquired and learned that by accident, not all the DNR files were made available for our review. Jeff White with the IDNR and James Gastineau with Aon Risk Management provided additional files to fill these data gaps. We contacted Nick Kohlhof and Marty Soole, well drillers who installed most of the private wells in Climbing Hill. Both drillers had indicated that they had substantial information on past drilling activities in Climbing Hill and that these files were available for review.

Mr. Soole made available the well logs for the Schlies well, Church well, old Benjamin well, old Barn well, and Parker well. Mr. Soole's information is provided as Attachment D. Although Mr. Kohlhof was initially optimistic about the information that he would find in his files, he later realized that the excavation contractor for the School District had not returned the well logs that Mr. Kohlhof had loaned him. However, Mr. Kohlhof provided information on the local geology over the entire duration of this project. As a result of the cooperation that both Mr. Soole and Mr. Kohlhof provided, information was obtained for nearly all of the private wells that had been in the assessment area.

In addition to the wells listed above that were drilled by Mr. Soole, Mr. Kohlhof drilled the Hancock, Garvey, and School wells and his father drilled the Bank well, Lloyd well, Schulz well, and Ross well. It is our understanding that Mr. Kohlhof's father drilled at least some of these wells by cable tool. Mr. Kohlhof was able to locate written records on the Bank well which indicated that the well was cable tool drilled in 1947 and is 127 feet deep with open hole completion in sandstone. Mr. Kohlhof indicated that the Lloyd, Hancock, Garvey, and Ross wells were drilled and completed between 100 and 110 feet. No sandstone was encountered and all three well were completed with slotted screen in a grey sand. The Schulz well was completed as a sand point well to depth of 68 to 70 feet.

Another source of information was work performed by EnecoTech, especially the results of video inspection. The McCoy well had open-hole completion in sandstone from 92 feet to 115 feet. This appears consistent with the 127 foot depth and open-hole completion of the Bank well. Video inspection indicated the Lloyd well was 87 feet deep and the old Benjamin well was 76 feet deep. Because of the discrepancy between Mr. Kohlhof's recollection of the Lloyd well and the well depth observed during video inspection, the well depths Mr. Kohlhof provided by memory appear uncertain. The depth observed at the old Benjamin well is similar to the 78 foot depth reported by Mr. Soole. The natural gamma logs of these same wells did not provide useful information.

The geological descriptions provided in well logs for the Climbing Hill area require additional explanation. For example, EnecoTech description of the coarse alluvial layer above the glacial till as an eolian cover sand is likely incorrect. We have reviewed Mr. Soole and Mr. Kohlhof logs at other sites and further questioned both drillers regarding their soil descriptions. We have concluded that their description of glacial till is ambiguous. Mr. Soole description of glacial till ranges from simply "clay" to "stks sand & dark gray clay". Mr. Soole explains that streaks of sand primarily describes the sand content of the clay and does not necessarily indicate individual sand features. Both drillers have a history of referring to very stiff unweathered grey till as shale.



The information obtained from the drillers was compared to other geological information. Based on the soil boring and our knowledge of this area, the log for MW-16 indicates that loess extends to a depth of 57 feet and that a two-foot gravel layer occurs below the loess. Glacial till occurs below this gravel layer to the bottom of the soil boring at 68 feet. The gravel layer appears to correspond to an alluvial layer separating the loess and till at several locations and based on well logs can be very coarse. For example, a rock and gravel layer was encountered between 52 and 55 feet at the Benjamin well, a rock layer was encountered between 54 and 55 feet at the old Barn well, and rocks, sand and green clay was present between 56 to 57 feet at the Parker well.

The description of green clay associated with rocks and sand at the coarse alluvial layer at the Parker well is very noteworthy. The discoloration of the clay is likely from the anaerobic effects of petroleum or other organic contaminants. This coarse alluvial layer at the base of the loess deposits appears laterally extensive. Because the vertical permeability of loess is much higher than the underlying glacial till, contaminants at the water table will easily reach this alluvial layer and can migrate horizontally in the alluvial layer more rapidly and with less resistance and attenuation than within the loess deposits. As a result, groundwater monitoring at the water table may not detect underlying contaminant migration within the alluvial layer.

The geologic information is summarized in Figure 3. A review of these descriptions indicate that old Benjamin well, the old Barn well, and the Parker well do not appear to have penetrated the alluvial aquifer above the Dakota Formation. For example, at the old Barn well gray sand was noted between 69 feet and 75 feet, however, gray clay and shale underlies this sand. The gray sand may have been localized sand deposits associated with the glacial till and most of the water produced by the well may have originated from the coarse alluvial layer indicated as rocks at 55 feet. If the water production from the well appeared limited, the filter pack was likely extended upward through the coarse alluvial layer.

Mr. Kohlhof believed that the wells impacted by petroleum contamination were drawing in shallow groundwater because of their slightly shallower depths. Mr. Kohlhof also indicated that production from the alluvial aquifer was more limited on the south side of Deer Run Trail. For example, Mr. Kohlhof indicated that the Ross well was deeper than the wells installed by Mr. Soole but its water yield was still limited. Mr. Kohlhof was forced to throttle back the pump in the Ross well to avoid excessive drawdown. With shallower wells and a more limited lower aquifer water source, considerable water may have been removed from the relatively thin alluvial layer resulting in an increase rate of contaminant migration from the upgradient source area.

Glacial till is absent and sand becomes prevalent to the west. At the School well, glacial till appears limited to a thin layer between 68 and 72 feet. Glacial till is not noted in the test log for the West Association well. At the Church well, glacial till appears to occur between 55 and 80 feet. Glacial till is noted in the test log for the East Association well between 55 and 65 feet, a considerable change in thickness in the less than 200 feet horizontal distance separating the Church and East Association wells.

An EnecoTech report dated August 12, 1999 discussed soil boring SB-1 that was advanced at the rear of the Benjamin Site. Although that report discusses sand interbedded with clay layers as shallow as 42 feet, we did not use this information because it is not consistent with other data and because the soil

boring log was not made available for our review. The 2001 test well was installed approximately 800 feet north of the Benjamin site. The EnecoTeck report on the test well dated May 2, 2001 contained major discrepancies with respect to soil descriptions. That report indicated 68 feet of glacial till to a depth of 126 feet although the driller's log indicated sand throughout much of this interval. Neither the driller's log nor EnecoTeck's descriptions are consistent with other information for this area.

The presence of sandstone at depths of only 92 feet at the Parker well and above 127 feet at the Bank well does not correlate with the surrounding stratigraphy observed at other locations with reasonably reliable soil descriptions. The presence of the much younger Salt and Pepper Sand at the association wells to a depth of at least 125 to 130 feet indicates erosion and alluvial channeling of the sandstone. Alluvial channels in the Dakota Formation could potentially create a complex alluvial geology especially if the channeling and deposition occurred over an extended period of time in differing conditions and environments. This complexity will certainly influence groundwater flow patterns and possibly explain the extreme differences in water quality within relatively small distances.

In summary, geology and stratigraphy exhibits considerable variation in Climbing Hill. However, the basic element of a relatively thick layer of loess overlying glacial till appears continuous southeast of the West Association well. The relatively thin coarse alluvial layer separating the loess and till also appears present at most locations. The migration of petroleum contamination to private drinking water wells likely occurred in this alluvial layer and drinking water contamination was primarily dependent on well depth and construction. The thickness of glacial till appears to vary considerably across this area from 2 feet to 25 feet. The geology below the glacial till appears much more complex and is likely dominated by alluvial channels cut into the sandstone of the Dakota Formation.

### Conclusions and Recommendations

The December 2009 groundwater monitoring report indicated that the source area groundwater concentrations at both sites have decreased since last sampled in 2004 or 2006. The contamination maps in the December 2009 report illustrated the decreased areal extent of the contaminant plumes. Although contamination is not present at the water table at MW-16, this monitoring well is screened below the water table and trace levels of petroleum contaminations continue to be detected at this well. MW-119R is located in the downgradient transition zone for the Benjamin site and contaminant levels increased from levels detected in 2006.

Initial water quality testing of the Benjamin well indicated a nitrate concretion of 43 mg/L, over four times the maximum contaminant level (MCL). As a result of this initial testing, further evaluation of the Benjamin well as an alternative water source was suspended. A more definitive second test indicated a nitrate concentration of 31.6 mg/L. Two consecutive samples collected from the Bank well tested positive for total coliform bacteria. An initial sampling of the School well detected trace levels of BTEX indicative of gasoline contamination. Analysis of follow-up samples collected from the School well at the same time but from two separate locations did not detect contamination.

Due to access problems, water elevation data was obtained from only five water supply wells and due to this data limitation, caution should be used in drawing any conclusions from this survey. The water elevations at the wells appear to generally correspond to the land surface elevation. Groundwater flow at the water table that occurs in the loess appears to be primarily in a westerly direction towards the

West Fork of the Little Sioux River. However, monitoring wells are not located near the School well which is located on top of a slight hill. The results of this survey indicates that groundwater flow in the alluvial sand and the overlying loess might be similar and suggests that the alluvial sands are hydraulically connected to the more shallow groundwater at the water table.

A large amount of geological information was reviewed for this report. Although geology and stratigraphy exhibits considerable variation in Climbing Hill, the basic element of a relatively thick layer of loess overlying glacial till appears continuous southeast of the West Association well. The relatively thin coarse alluvial layer separating the loess and till also appears present at most locations. Because the vertical permeability of loess is much higher than the underlying glacial till, contaminants at the water table will easily reach this alluvial layer and can migrate horizontally in the alluvial layer more rapidly than within the loess deposits. As a result, groundwater monitoring at the water table may not detect underlying contaminant migration within the alluvial layer.

The continued detection of petroleum contamination at MW-16, which is screened below the water table, and the absence of contamination at MW-6, which is located adjacent to MW-16 and is screened at the water table, indicates that the mechanism of contaminant transport discussed above continues to occur. We conclude that the migration of petroleum contamination to private drinking water wells likely occurred in the thin alluvial layer at the base of the loess and drinking water contamination was primarily dependent on well depth and construction. The thickness of glacial till appears to vary considerably across this area and the geology below the glacial till appears much more complex and is likely dominated by alluvial channels cut into the sandstone of the Dakota Formation. We conclude that this complexity may explain variations in water quality within relatively small distances.

The detection of bacteria in the drinking water from the Bank well and the overall condition of the well is a major concern. We informed Mr. Pat Benjamin that if this well continues to be used as a source of drinking water, significant steps must be performed to recondition the well. These include chlorination treatments to sanitize the well and water distribution system and upgrading the well to include use of a sanitary well seal. Mr. Benjamin indicated that he does not plan to reconnect to the East Association well because of water quality issues. It is our understanding that Mr. Benjamin plans to connect the apartment building and the beauty shop to the well located near his house. Although the Benjamin well has an elevated nitrate level, we consider the Benjamin well to be a safer source of drinking water than the Bank well.

Although not specifically listed as an action required prior to the next conference, it is our understanding that the IDNR expects this report to include recommendations on future monitoring in Climbing Hill. Although we anticipate that the Bank well will be plugged later this year and that the apartment building and beauty shop will be connected to the Benjamin well, our proposed monitoring plan covers use of the Bank well as a drinking water source. The primary dilemma with development of a monitoring plan is that the IDNR has indicated that the objective is "to monitor groundwater contamination in the deep sand aquifer(s)", however nearly all of the available monitoring points are completed at the water table in the overlying loess.

We recommend that the existing groundwater monitoring wells be used to monitor plume stability and attenuation. Although sampling existing groundwater monitoring wells completed at the water table will not provide the total areal extent of groundwater contamination, these monitoring wells remain an

important indicator of plume stability because past impact to drinking water wells were frequently indicated by trace levels of groundwater contamination detected at the water table. The Tier 2 software was used to assist in developing a monitoring plan utilizing the existing groundwater monitoring wells. As discussed below, we revised the Tier 2 model to include a reasonable Tier 2 monitoring plan because the well selection process performed by others did not appear complete.

Although the Church and East Association wells are located outside the receptor identification plumes, various monitoring wells for these two receptors and risk classifications appeared in the Tier 2 Monitoring Plan or the SMR Monitoring Plan Summary Table depending on the version of the model being used and as new groundwater data was entered. Although these model variations and anomalies were annoying, we used the model only to assist in developing a monitoring plan. The proposed monitoring plan is provided as Table 5. Because of past analytical results and the recent analytical results from MW-119R, the proposed monitoring plan includes both OA-1/MTBE and OA-2 analysis of all samples. The details and rationale of the monitoring plan is further discussed below.

The source well at the Benjamin site is MW-117 and this well is included in the monitoring plan. MW-105 and MW-21A are not intended as long term monitoring locations if another round of groundwater sampling confirms the December 2009 results and therefore the monitoring plan indicates a one time sampling event. Monitoring of MW-118 and MW-106 can be discontinued after the Bank well is plugged. MW-122, MW-103, and MW-109 are included to monitor groundwater contamination between the groundwater source at the Benjamin site and the East Association well. MW-119R is included in the monitoring plan as a transition well and because of the significant increase in the TEH-diesel concentration. The inclusion of MW-6 and MW-16 in the monitoring plan is further discussed below.

In addition to monitoring groundwater contamination at the water table two additional groundwater zones are of interest. The next groundwater zone below the water table is associated with the thin alluvial layer between the loess and the underlying till. It is our opinion that this alluvial layer is the primary pathway that contamination migrated to drinking water wells impacted by contamination. MW-16 is the only monitoring well deep enough that can potentially detect contamination in this zone. As discussed below, the current depth of MW-16 may limit the effectiveness of this well to monitor the fine alluvial layer. It is our opinion that during previously assessment activities, this zone should have been an assessment priority.

Although contaminant migration in the thin alluvial layer at the base of the loess deposits can not be effectively monitored with existing wells, MW-6 and MW-16 are both included in the monitoring plan to provide at least some limited monitoring capability. MW-6 is completed at the water table and the well construction diagram for MW-16 indicates a screened interval between 64 and 68 feet and a filter pack extending upward to a depth of 58 intersecting the alluvial layer at 59 feet. Our primary concern with this well is based on our field measurements that indicated a hard well bottom at a depth of 50 feet after redevelopment to remove sediment. Because contamination was detected, we assume that only a partial obstruction is present at 50 feet.

The next groundwater zone below the thin alluvial layer and the underlying glacial till is the alluvial aquifers. This zone was referred to by the IDNR as the deep sand aquifers. The existing water supply wells, except the Bank well, are likely completed in this zone. The association wells are likely at least

partially completed in this zone. Existing monitoring points include the Lloyd and Garvey wells. Although these wells already have an extensive sampling and analytical history, the Lloyd and Garvey wells are included in the monitoring plan because the wells are screened in the alluvial aquifers. Sampling of the Bank well should continue until this well is plugged. Because of the initial detection at the School well, we recommend that this well be sampled one more time.

At the time of the survey, a large amount of water was being pumped from the Benjamin well to fill an outdoor pond. The water flow was temporarily stopped to obtain water levels. A measurable water level recovery was not observed in the well indicating a high yield well with little if any substantial drawdown. It is our opinion that based partially on the water level survey and the well yield under sustained pumping, the Benjamin well can be used as a common drinking water source with little risk of future petroleum contamination. At this time we are not recommending additional assessment of the Benjamin well but we have included this well in the monitoring plan. It is also our opinion that the UST Fund pay for connection to the Benjamin well because these costs are clearly a result of the UST petroleum release.

Our primary concern in Climbing Hill is the potentially rapid migration of contamination in the thin alluvial layer if drought conditions occur. Although we have no way of predicting the groundwater contaminant migration in the thin alluvial layer, source area concentrations often increase during periods of low water levels and with a lowering of the potentiometric surface of the underlying alluvial aquifers, downward migration of contamination seems intuitively more likely. It is our opinion that Tier 2 modeling is entirely ineffective in predicting risk to drinking water receptors under these conditions. Although we are not proposing additional assessment at this time, installation of at least a limited number of intermediate monitoring wells screened at the loess/till interface should be considered.

Because of the concern of the IDNR regarding the elevated groundwater table during the December 2009 sampling event, we are proposing semi-annual monitoring during the second and third quarters, to cover seasonal variations of water levels to the extent practical. However, a variance on the 180-day rule between sampling events must be allowed, otherwise winter weather conditions and snow cover will likely eventually be encountered during future fourth quarter sampling events as occurred this past December. We recommend that the frequency of monitoring be evaluated annually and that annual monitoring instead of semi-annual monitoring be established as soon as possible. If continued plume stability and attenuation is observed, the number of wells monitored should be decreased.

There are some miscellaneous items that should be discussed. As discussed in earlier this report, the elevation of several of the monitoring wells associated with the Benjamin site were compared to their previously reported elevations using the monitoring wells at the School District site as a reference. This comparison indicated discrepancies in the elevation that could effect estimating the direction of groundwater flow. As a result, we recommend that a more thorough elevation survey be performed as part of the next monitoring event. As previously noted in this report, the well cover for MW-119R is damaged and needs to be replaced. Finally, it continues to be our recommendation that the School District site be reclassified to "No Action Required".

## Attachments

### Table

- Table 1 – Well Descriptions and Designations
- Table 2 – Inorganic Water Quality Sampling Results
- Table 3 – Organic Water Quality Sampling Results
- Table 4 – Water Level and Elevation Survey Results at Water Supply Wells
- Table 5 – Proposed Monitoring Plan

### Figures

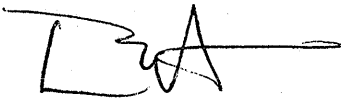
- Figure 1 – Site Plan Map
- Figure 2 – Water Level Elevations at Water Supply Wells and Topographic Map
- Figure 3 – Summary of Lithological Descriptions

### Attachment

- Attachment A – Laboratory Analytical Reports
- Attachment B – SMR for School District site
- Attachment C – SMR for Benjamin site
- Attachment D – Well Logs for Water Supply Wells

If you have any questions regarding this report, please contact our office at 712-756-4732.

Respectfully submitted,



Daniel Ruppert  
Certified Groundwater Professional

cc: Ms. Ruth Hummel, IDNR

- Mr. James Gastineau, Aon Risk Management
- Mr. Jerry Steffen, Steffen Engineering & Testing
- Mr. James Pray; Brown, Winick, Graves, Gross, Baskerville and Schoenebaum, P.L.C.
- GAB Robins

**Table 1**  
**Well Descriptions and Designations**

Benjamin Tier 2 Well Description	Benjamin Tier 2 Well Designation	WCSD Tier 2 Well Description	WCSD Tier 2 Well Designation	Current Well Description	Current Well SMR Designation
Kamm Well #1	DWW-1	Kamm Well	DWW-4	Garvey Well	NDWW-2
Schultz Well #2	DWW-2	Schulz Well	DWW-3	Schulz Well	plugged
Benjamin Well 3c	DWW-3c	none	none	Benjamin Well	DWW-3
Benjamin Well 3b	none	none	none	Old Benjamin Well	plugged
Parker Well #4	DWW-4	Parker Well	DWW-6	Parker Well	plugged
McCoy Well #5	DWW-5	none	none	McCoy Well	plugged
Jackson (Bennette) #6	DWW-6	none	none	Jackson Well	plugged
Lloyd Well #7	DWW-7	Lloyd Well	DWW-1	Lloyd Well	NDWW-1
Barn Well #8	DWW-8	Trading Post Well	DWW-2	Old Barn Well	plugged
Bank Well #9	DWW-9	none	none	Bank Well	DWW-9
Schlies Well #10	DWW-10	none	none	Schlies Well	DWW-10A
Ross Well #11	DWW-11	Ross Well	DWW-5	Ross Well	plugged
Church Well #12	DWW-12	none	none	Church Well	DWW-12
none	none	County Shop Well	DWW-8	County Shop Well	plugged
none	none	Wolfs Well	DWW-10	Hancock Well	DWW-10B
none	none	none	none	East Association Well	DWW-13
none	none	none	none	West Association Well	DWW-14
none	none	none	none	Barn Well (new)	none
none	none	none	none	School Well	DWW-15
none	none	none	none	Farm Well	none

**Table 2**  
**Inorganic Water Quality Sampling Results**

Well Description	Sample Date	Iron	Manganese	Sulfate	Hardness	Nitrate	Total Coliform Bacteria
E. Association Well	12/11/2009	<0.1	0.271	NA	NA	<0.1	Not Present
W. Association Well	12/11/2009	<0.1	<0.0100	NA	NA	1.18	Not Present
Barn Well	12/11/2009	5.25	0.0417	NA	NA	1.80	Present
Benjamin Well	03/23/2010	<0.1	0.1	50	380	43	Not Present
Bank Well	04/29/2010	NA	NA	NA	NA	NA	Present
Bank Well	05/01/2010	NA	NA	NA	NA	NA	Present
Bank Well	04/29/2010	0.978	<0.0100	31.8	316	<0.10	NA
Benjamin Well	04/29/2010	NA	NA	NA	NA	31.6	NA

Concentrations are in mg/L which is equivalent to parts per million (ppm). For comparison, the December 2009 data is also presented.

**Table 3**  
**Organic Water Quality Sampling Results**

Sample	Date	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE	TEH-D	TEH-WO	TEH-Gas
School Well Outside	04/22/10	2.57	4.81	11.9	44.4	<1.00	<300	<300	<300
Bank Well	04/22/10	<1.00	<1.00	<1.00	<3.00	<3.00	<300	<300	<300
Hancock Well	04/22/10	<1.00	<1.00	<1.00	<3.00	<1.00	<333	<333	<333
School Well Inside	05/10/10	<1.00	<1.00	<1.00	<3.00	<3.00	NA	NA	NA
School Well Outside	05/10/10	<1.00	<1.00	<1.00	<3.00	<3.00	NA	NA	NA

Concentrations are in ug/L which is equivalent to parts per billion (ppb).



**Table 4**  
**Water Level and Elevation Survey Results at Water Supply Wells**

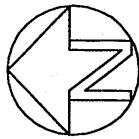
Well Location	Date	Ground Surface	Top of Casing	Water Level
Garvey Well	05/01/2010	1,124.6	1,125.24	1,096.96
Lloyd Well	05/01/2010	1,127.9	1,128.70	1,095.40
Bank Well	05/01/2010	1,127.6	1,127.58	1,097.20
Benjamin Well	05/01/2010	1,132.8	1,134.35	1,099.45
School Well	05/01/2010	1,131.5	1,132.32	1,097.97

Elevations are shown in feet ASL (Above Sea Level)

**Table 5**  
**Proposed Monitoring Plan**

Well	Monitoring Target	Receptor	Monitoring Type	Frequency
MW-6	water table	downgradient receptors	downgradient guard well	semi-annual / annual
MW-16	thin alluvial layer	downgradient receptors	downgradient guard well	semi-annual / annual
MW-21A	water table	NDWW-1	source well*	once
MW-103	water table	DWW-13	guard well	semi-annual / annual
MW-105	water table	downgradient receptors	downgradient guard well	once
MW-106	water table	DWW-9	transition & guard well	semi-annual / annual **
MW-109	water table	DWW-13	guard well	semi-annual / annual
MW-117	water table	DWW-13	source well	semi-annual / annual
MW-118	water table	DWW-9	exceed & transition well	semi-annual / annual **
MW-119R	water table	downgradient receptors	downgradient transition well	semi-annual / annual
MW-122	water table	DWW-13	exceed & transition well	semi-annual / annual
Bank Well	Dakota sandstone aquifer	DWW-9	actual receptor	semi-annual / annual **
Benjamin Well	? alluvial aquifers	DWW-3	actual receptor	semi-annual / annual
Garvey Well	? alluvial aquifers	NDWW-2	actual receptor	semi-annual / annual
Lloyd Well	alluvial aquifers	NDWW-1	actual receptor	semi-annual / annual

\* MW-21A is the current source well for the School District site. \*\* Discontinue sampling after Bank well is plugged.



SCALE: 1" = 80'

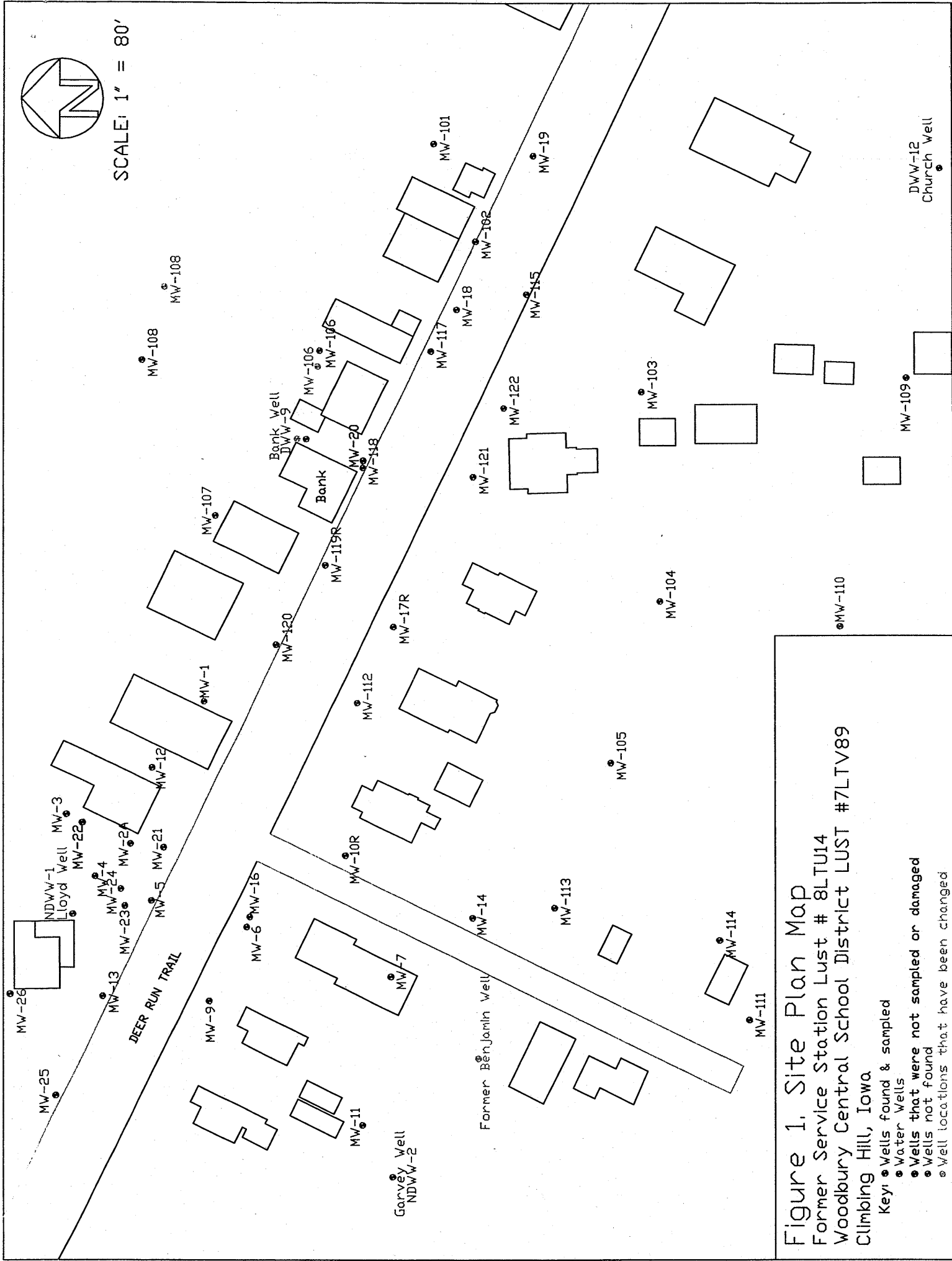


Figure 1. Site Plan Map  
Former Service Station Lust # 8LTU14  
Woodbury Central School District LUST #7LTV89  
Climbing Hill, Iowa

- Key:
- Wells found & sampled
  - Water Wells
  - Wells that were not sampled or damaged
  - Wells not found
  - Well locations that have been changed

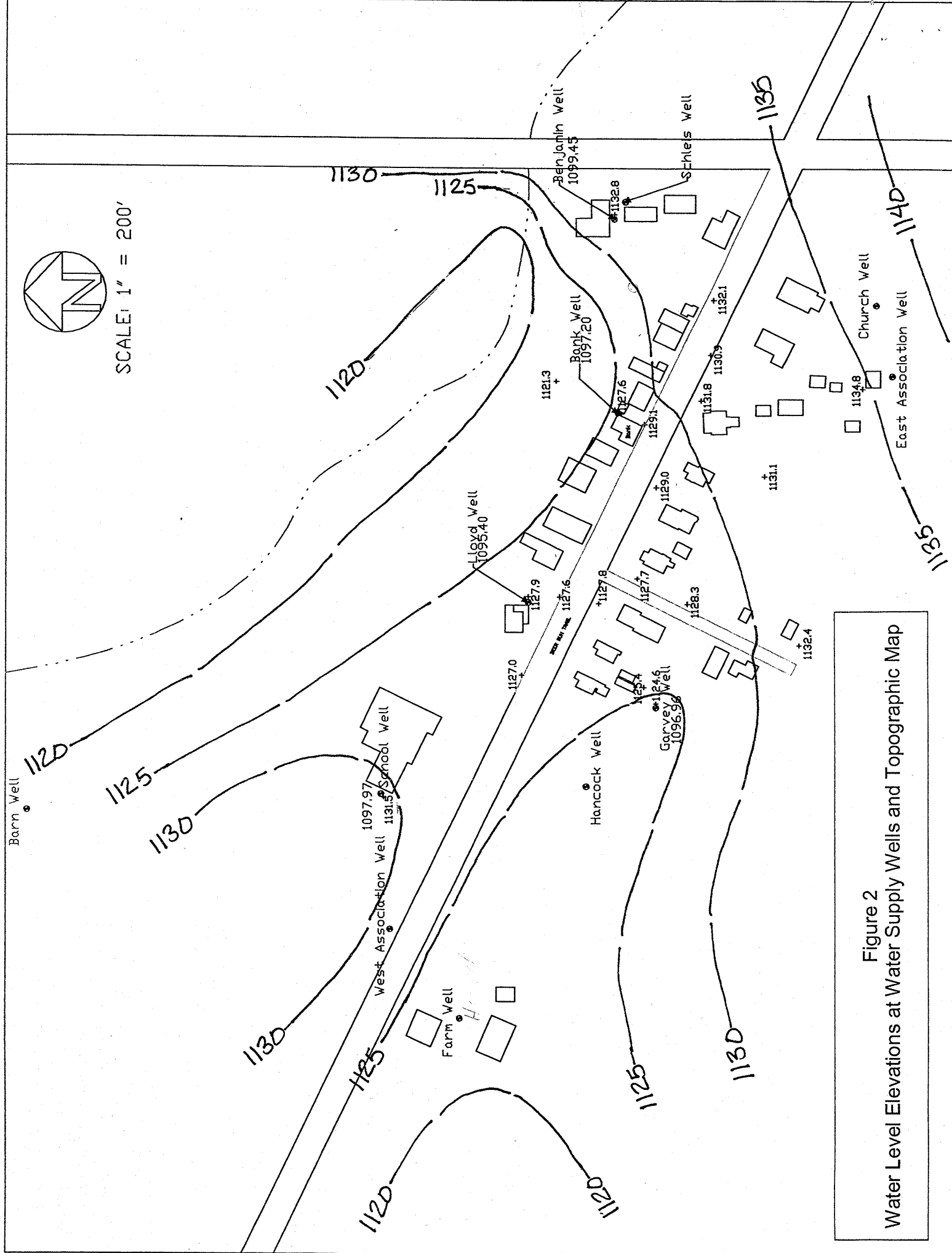


Figure 2  
Water Level Elevations at Water Supply Wells and Topographic Map



SCALE: 1" = 200'

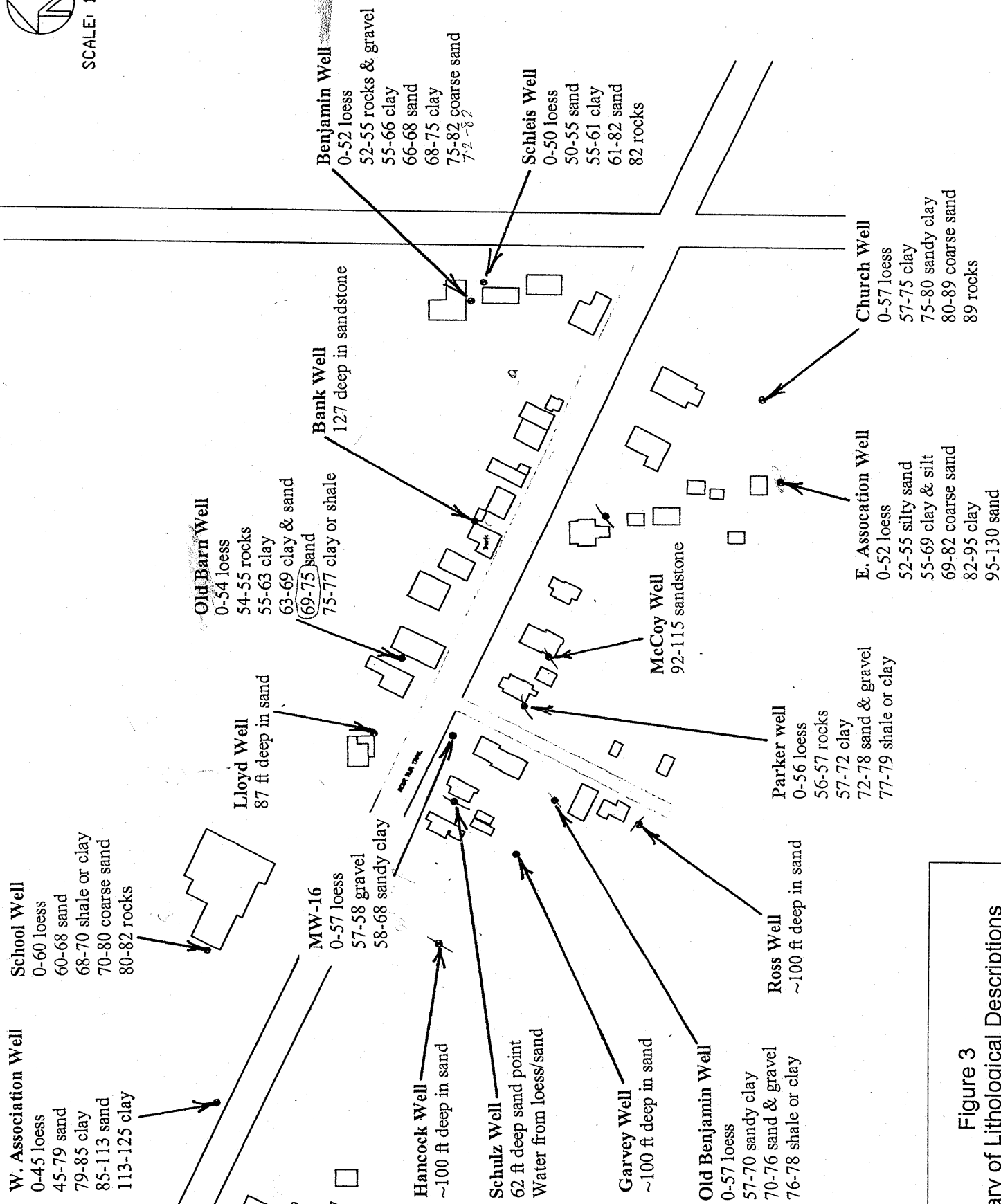


Figure 3  
Summary of Lithological Descriptions

